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The Parasitism of Root Knot Nematodes: A Mini review

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Abstract

Phytonematodes, or plant-parasitic nematodes, are considered to be among the most important economic pathogens around the world. Plant tissues are the main source of food for plant parasitic nematodes. There are thousands of nematodes genera, but the root-knot nematodes (*Meloidogyne* spp.) were and still the most dominant and destructive genus around the world. *Meloidogyne* spp. Cause an estimated Annual Loss of $157 billion globally. Root-knot nematodes release certain proteins that modifying the plant cell wall to disrupt it, in addition to the mechanicals hearing by the style to fthenematode. The parasite is m proteins secreted by root- knot nematode might include plant cell wall modifying enzymes, besides proteins that are capable of localizing in the host plant cell nucleus, suppressors of host defense, proteins that can mimic plant proteins as reported in other cyst and root knot nematodes.

Keywords: Root-Knot Nematodes; Plant Cell-Wall; Life Cycle; Parasitism; Degrading Enzymes

Introduction

Plant parasitic nematodes (PPN) are tiny Microscopic worms and occur abundantly in soil. Moreover, plant parasitic nematodes are the hidden enemy of crops and are one of the many groups of harmful organisms which depend on plants for their survival and reproduction [1]. PPN infesting several growing crops, such as vegetables and leguminous crops, oil crops, fiber crops, grain crops and fruit trees next to weeds which are the secondary host to parasitic nematodes [2]. Among the root-knot nematodes, *Meloidogyne javanica* (Treub) *Chitw*., *M. incognita* (Kofoid and White) *Chitw*., *M. arenaria* (Neal) *Chitw*., and *M. hapla Chitw*. are the major agronomic importance, being responsible for at least 90% of all damage caused by nematodes form any cultivated crops around the world [3,4].

The root-knot nematodes (*Meloidogyne* spp.) are endoparasitic & sedentary nematodes which complete their life cycle inside the plant tissues and produce large numbers of eggs, which accumulate in masses attached to their bodies. Otherwise, the common symptoms of the infestation with root-knot nematode are stunting, yellowing and wilting, but the major symptom is the gall formation in plant roots [2]. The estimated annual losses to world crops by plant parasitic nematodes are $118b [5]. Plant parasitic nematodes feed on living plant tissues, using an oral styled to puncture host cells. All plant nematodes inject enzymes (saliva), in to a host cell before feeding. The saliva stimulates cell enlargement and also liquefies part of the contents of the cells, which are then withdrawn by the nematode through its styled. Therefore, this simple mini-review aimed to make as mall notification, for those interesting by parasitism of root-knot nematodes and how nematodes grade the plant cells wall. Also, it is helpful for those work or study in field of pest management to understand the parasitism mechanisms.

Life Cycle and Giant Cell Formation of Root-Knot Nematodes

The life cycle of root-knot nematode from egg to egg is complete in about 25 days at 27°C, but it could be increased or decreased expending on the levels of temperature (lower or higher). Each female lays approximately 500eggs in a gelatinous mass produced by the female from rectum glands. Embryo genesis within the egg is transformed to the second stage juvenile after the first molting. The second-stage juveniles (J2) considered the infectious stage which starts immediately seeking about the host [6]. Nematodes use their chemo receptors to find the host and this depending on the root exudates of the host plant [7]. Moreover, juveniles (J2) penetrate the root just behind the root tip and migrate between cells until staying near to vascular cylinder. The second-stage juveniles may migrate from within galls to adjacent parts of the root and cause new infections in the same root, or they may emerge from the root and infect other roots of the same plants or roots of other plants.

The second-stage juveniles (J2) induce about five to seven parenchymatic root cells into multinucleate and hypertrophied feeding cells. These transformed root cells are the giant cells which function as specialized source to provide nutrients to the nematodes until reproduction. During feeding process, the nematode becomes sedentary, going through three molts before becoming a mature adult. Most RKNs reproduce by parthenogenesis [8]. Males migrate out of the plant and play no role in reproduction. After the development of the pear shaped female, eggs are released on the root surface in a protective, gelatinous matrix. It is so easy to distinguish between male and female of root-knot nematodes through the morphological form. The males of root-knot nematodes are worm like and about 1.2 to 1.5mm long by 30 to 36μm India meter. Whereas, females in last stage are pear shaped and about 0.40 to 1.30mm long by 0.27 to 0.75mm wide.

Giant-cells expand rapidly, reaching their full size during 2 or 3 weeks after onset of nematode feeding [9]. The induced cells by root-knot nematodes are between three to six giant-cells to feed from. The first sign of giant-cell induction is the formation of binucleate cells [10]. Giant cells have a very dense cytoplasm containing numerous mitochondria, plastids, ribosomes, a well-developed Golgi apparatus and smooth endoplasmic reticulum, generally organized in swirls [10]. The vacuole disappears and gives rise to many small vacuoles. To enhance solute up take from the vascular system, cell wall ingrowths develop in contact with the xylem. Thus, mature giant cells are metabolically active and act as transfer cells for the feeding nematode. Historically, Nemec was the first scientist who explains the mode of giant-cell information [11]. He mentioned that development of giant-cells occur by expansion of cell without degradation of cell wall. Also, he clarified that the cell extension is accompanied with repeated rounds of mitosis without cell wall formation providing an explanation for the high numbers of nuclei in these large cells.

Parasitism of Root-Knot Nematodes

Parasitism genes which found in root knot nematodes are responsible for production of Parasitism proteins that secreted by the nematode and play a direct role in plant parasitism [12]. The secreted proteins are mostly originated from the esophageal gland cells, but secretions from the chemo sensory amphids might also be important [13]. In most cases of parasitism the second stage juvenile (J2) is the infectious stage who initiate the parasitic relationship with the host by releasing their secretions into the root cells through its style which stimulate the root cells of the host to become specialized feeding cells (giant cells), which considered the essential and only source of nutrients for the nematode's survival [14,15]. Plant cell walls serve as obstacles. nematodes release a mixture of cell-wall-digesting enzymes to break structural plant cell walls [15]. Mean while, migratory plant nematodes that enter plant tissues facing additional obstacles to feeding through different tissues, as well as evasion of host defense [16]. Zenov'eva et al. [17] summarized several gene products isolated from sub-ventral glands of nematodes which included lipo protein, cellulose-binding protein, endo-glucanase, chitinase, pectinase and proteinase.

Enzymes Involved in Cell Wall Breakdown

Calreticulin: Calreticulin like proteins are also reported to be secreted from other plant parasitic nematodes and play a role in the interactions among parasite and host [18,19]. A calreticulin-like protein preceded by a signal peptide was also reported to be secreted from the sub-ventral glands of a root knot nematode [20].

Cellulase: After the hatching of eggs, the juveniles of root-knot nematodes are needed to penetrate the root of host plant to complete their life cycle. The main structural component of the plant cell wall is Cellulose which needs to degrade by Cellulase enzyme. Cellulases are responsible for the hydrolysis of β- 1, 4-glucosidic linkages. The Celluloses enzymes were identified in the sedentary nematode genre a as *Meloidogyne, Heterodera and Globodera* [21]. The plant cell wall digesting enzyme cellulose gene is already described for root knot nematodes [14,22,23].

Chorismate Mutase: The enzyme chorismate mutase is proved to be involved in early development of the feedings it as induced by plant parasitic nematodes, but how this enzyme alters the development of plant cells is not properly known [24]. The first animal chorismate mutase gene (Mj-cm-1) was cloned from (*Meloidogyne javanica*) and found to be expressed in the oesophageal gland cells of the nematode [25]. Chorismate mutase was also identified from soybean and potato cyst nematodes recently [26-28].

PectateLyase: Certain evidences proved that Pectatelyases enzymes are produced and released during the process of nematode penetration and migration or not at all during these dentary stages of the nematodes [14,29,30]. Pectatelyases enzymes were identified in many genre a such as *Meloido gyne* spp., *Heterodera, Globodera and Bursaphelenchus* spp. [14,31]. Moreover, some reports mentioned that the pectinase proteins obtained from root knot nematodes was of the type pectatelyase which is found in fungi and bacteria [32,33].

Polygalacturonase: The first recorded animal Polygalacturonases (PGs) enzymes were reproduced from *Meloidogyne incognita* [34]. Polygalacturonases are enzymes that catalyze the degradation of pectins which is major plant cell wall components, in another word, the poly galacturonase which produced by *M.incognita* could play an important role in weakening the plant cell wall so root tissue during nematode penetration and inter cellular migration by the parasite like other nematode parasitism genes [35]. Also, PGs enzymes

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stimulate the hydrolysis of pectic-polygalacturonic acid and turn release oligo galacturonides.

Xylanase: Xylan is the widest spread poly saccharide in nature after cellulose. The functional characterizations of endo-1, 4-β-xylanase was obtained for the first time from the southern root-knot nematode (*Meloidogyne incognita*). The nematode endo-xylanase has similarity to bacteria lendo-xylanases [36].

Conclusion

The main purpose of this review is to throw alight and or make an instant notification about the parasitism of plant parasitic nematodes especially root-knot nematodes (RKN). In this review we can clarify some points about the importance of some modifying enzymes which play role in penetration processes, besides the mechanical penetration by the stylet. Cellulase, Polygalacturonase, Xylanase and others which considered cell wall modifying enzymes' were proved to be released by certain plant parasitic nematodes including RKN.

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